THE MACHINABILITY AND SERVICEABILITY OF MATERIALS.

Paper presented to the Institution, Western Section, by Professor F. Bacon, M.A., M.I.Mech.E.

ALTHOUGH machinability is such a real thing in the workshop, it proves to be extraordinarily difficult to isolate as a metallurgical or physical property which can be defined, measured and controlled. Of course, it is easy enough to indicate in a general way a combination of properties which can be counted on to confer good or bad machining qualities. Thus, a mild steel very low in carbon, very low in impurities, such as sulphur and phosphorus, and in the black hot-rolled condition, is bound to be difficult to machine. Conversely, a mild steel which contains at least 0.2% carbon will probably machine fairly well in a cold-worked condition, and will be rendered " free-cutting " by suitable additions of sulphur and phosphorus.

As machinability is influenced by structure, suitable heat-treatment can often be prescribed and controlled by micrographic examination. This is particularly true of mild steels where changes of structure produced by heat treatment are very marked. In other cases, e.g., semi-mild carbon steel, heat treatment may be effective although its influence on the microstructure is difficult to discern. Then there are special cases where chemical analysis and microscopic examination fail ; but according to Robinson and Nesbitt[1], the micro-structure proves to be a reliable guide to machinability of the kind needed in the boring of rifle barrels.

That the machinability of a ductile steel is an elusive quality is not really surprising when it is remembered that the action of the tool drastically deforms the material and also generates much heat ; so that the metal which is actually being sundered, viz., that which lies just ahead of the tool in the line of cut, may be both severely deformed and decidedly hot. In other words, the material is cold-worked and heated before it is cut, the exact pre-treatment being part of, and peculiar to, the particular cutting process. Hence, it would seem that we can hardly hope to devise an independent physical test which will yield an index of machinability applicable to all machining processes.

Limiting " machinability " to mean " turnability " in the lathe, the most widely accepted criterion is the cutting speed which

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blunts the tool in sixty minutes under specified conditions of test. For heavy roughing cuts, the influence of feed, depth of cut, tool shape, etc., has been exhaustively studied. The results are found to obey fairly simple laws which can be made conveniently available for use in the form of straight-line graphs. One such graph, based on extensive cutting experiments made at Aachen under the direction of Professors Wallichs and Opitz[2], is shown in Fig. 1. It will be seen that the horizontal scales on this graph

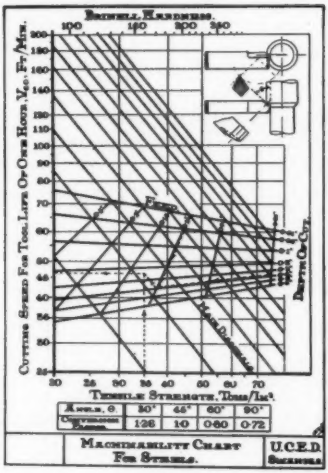

Fig. 1.

are tensile strength (below) and Brinell hardness number (above). Suppose we want to find the cutting speed which will blunt the tool in sixty minutes, when the material is 35 ton steel (or Brinell Hardness 160), using a depth of cut of 0.4 in. and a feed of 0.10 in. We find the intersection corresponding to the assigned feed and depth of cut, and through it we draw a line parallel to the system of parallel sloping lines marked "main diagonals." From the point where this inclined line cuts the vertical through 35 tons per square inch (or Brinell No. 160), we project horizontally on to the vertical scale, and read off 48 ft. per minute as the required cutting speed. This is for the standard tool form shown in the top right-hand corner of the figure. A table of conversion factors is given at the bottom of the figure for obtaining the corresponding cutting speeds for tools ground to angle θ greater or less than the standard form in which $\theta = 45°$. The diagram has been con-

structed for *dry* cutting with a tool of high-speed steel (18 to 20%W) quenched in train oil from 1,300°C. When lubricated with coolant, the speed can be increased 10%.

It will be observed that charts like Fig. 1 show in a rather surprising manner that a great many results of actual turning tests on *ordinary* steels can be reduced to law and order when the material is merely defined by its tensile strength of Brinell hardness number. Similar charts have been successfully prepared for cast iron where the material is defined by Brinell hardness number *only*, there being in this case no simple linear relation between hardness and tenacity. But such charts break down when we try to include free-cutting steels. Nor do they tell us what we require to know in the case of fine finishing cuts. That the original hardness of the steel can have no basic relation to machinability, since original hardness no longer exists in the metal as it is actually being cut, has been stressed by Mr. E. G. Herbert[3], who argues that the real measure of machinability is the hardness of the chip. As a measure of machinability even simpler than chip hardness, his proposal is to substitute the " maximum induced hardness " measured by the Herbert Pendulum time work-hardening test. This quality, he contends, is closely related to chip hardness, and it gives a similar, but more general measure of machinability as it does not depend on the particular form of cutting tool. It is also easier to measure than chip hardness. It cannot, of course, be applied to ascertain machinability in the case of brittle metals and machining conditions which do not produce work-hardened chips, e.g., it fails in the case of cast iron which separates without deformation of structure.

Investigators have naturally bestowed much attention on trying to ascertain what is actually the mechanism of chip-formation. The simplest way of examining the cutting process is to stop the lathe suddenly when a cut is in progress, and then photograph under suitable magnification the external appearance of the still-adhering chip. A striking series of photographs obtained in this way was published by Mr. J. F. Brooks[4] as long ago as 1905. A more elaborate study of chip formation was published by Messrs. Rosenhain and Sturney[5] in 1925. They experimented with a parting tool penetrating radially into a narrow collar previously turned on the work. The tool was forced into the revolving collar, and the lathe stopped abruptly before the cut had extended all round the periphery. The collar was then separated from the rest of the bar, and a transverse micro-section was prepared through the middle of the adhering chip. They classified their chips into three fundamental types which they named : " tear," " shear," and " flow " respectively. This classification has since come into general use. Sketches of the three types

of chip are reproduced in Fig. 2. It will be observed that in the " tear " type there is a cleft running ahead of the point of the tool,

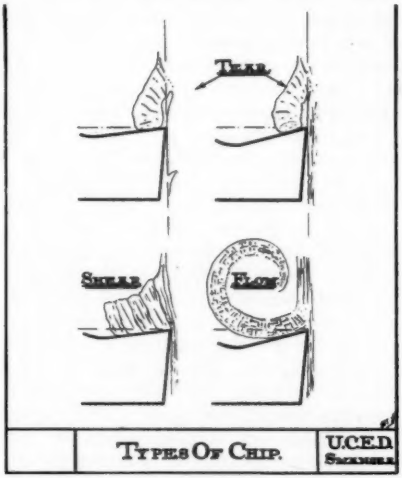

Fig. 2.

which cleft is liable to penetrate beneath the line of cut unless the tool has sufficient back rake. According to Mr. Herbert[3], this feature is peculiar to the commencement of cutting, and is never found in cuts which have been continued for any length of time. This is an important point which will be referred to again later. Free-cutting is always of the " flow " type with a curling chip. In the " shear " type, the chip crumbles away intermittently along inclined faces by a process which is mainly shearing. Due to heavy distortion, the " shear " type chip is usually thicker than the " flow " type for the same depth of cut.

An important part in chip-removal is often played by the so-called " built-up edge," composed of stratified layers of the material being cut. This wedge-shaped excrescence adheres to and protects the tip of the tool. When present, the " built-up edge " is the implement which actually does the cutting. As it seems to renew itself automatically, people always inquire why the tool ever requires sharpening. One way of answering this question is to say that the nose of the tool is worn away just behind the " built-up edge " by the eroding effect of the on-coming chip. Actually, the behaviour of the built-up edge is still shrouded in a good deal of doubt and uncertainty. Fig. 3 shows the rival views of two recent

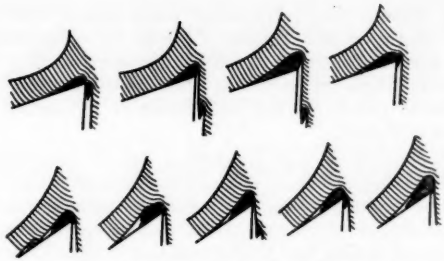

Fig. 3.—Behaviour of "built-up edge."

investigators. In the upper sequence due to Prof. Schwerd[6], bits of built-up edge are periodically left behind on the work ; in the lower sequence due to Prof. Doi[7], detached bits of built-up edge are sometimes left behind adhering to the work ; but mostly escape by passing away with the chip. Quite recently, with the aid of extremely elaborate equipment, installed in the Technical High School at Hanover, Prof. Schwerd[8] has managed to secure cinematograph films of high-speed cutting. He can take pictures at the rate of 1,000 to 10,000 per second with spark exposure lasting less than a millionth of a second. In his instantaneous photographs of high-speed cutting, the flow type chip seems to leave the tip of the tool without the least trace of built-up edge.

But in order to consider machining processes in relation to the serviceability of the article produced, special attention must be paid to the quality of the surface left by light finishing cuts and grinding processes. When the object is to produce a surface possessing high resistance to wear, the surface must be left as *smooth* as possible. How roughness is measured at Aachen[9], is shown in Fig. 4.

Fig. 4.—Effect of cutting speed on surface roughness. Material : Free cutting mild steel. Feed : 0.2 mm. ; depth of cut, 0.4 mm. Cutting speed (top) 30 m. per min. Cutting speed (bottom) 90 m. per min.

In the centre is a visual comparison secured by a special microscope which brings the images of two different specimens into the same field of view. The corresponding profilograph records are shown

above and below. The interesting point about this comparison is that the improved smoothness of the lower curve is entirely due to a higher speed of cutting. It is unnecessary to stop to consider how the profilograph functions, as your Institution has so recently had a valuable paper on the measurement of surface roughness by Mr. Harry Shaw[10].

A smooth surface is also needed to secure satisfactory resistance to alternating stresses, as it is well known that tool marks, and even fine scratches, readily promote fatigue cracks. Some results of the author's experiments on fatigue cracks made at Swansea are collected in Fig. 5. If the test-bar is smooth polished as at

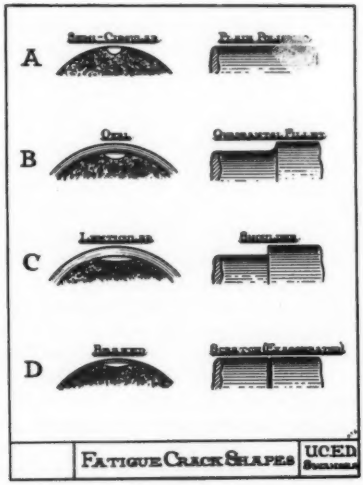

Fig. 5.

A, the fatigue crack starts as a tiny semi-circular patch. If the crack occurs at the foot of a fillet as at B, the crack is already elongated into oval form. This tendency to elongate under the influence of local concentration of stress is further intensified at C where the fillet is of such small radius as to be almost a sharp right-angled re-entrant corner. Lastly, at D we have the form of fatigue crack that starts from a fine transverse scratch actually far finer than the exaggerated groove it has been necessary to draw to render the picture clear. A new phenomenon now appears: In addition to the elongation already present at C, the crack is "beaked" with a reverse curvature at the corners, preparatory to running

round peripherally, even before the central depth of crack increases appreciably, so great is the stress-concentration at the bottom of the scratch. With a ground finish, it is only too easy to produce occasional scratches deeper than the average, which behave in this way, and which take a tremendous amount of fine polishing to remove.

The machining marks left by a round pointed turning tool are rather different. Fig. 6 purports to show diagrammatically how the

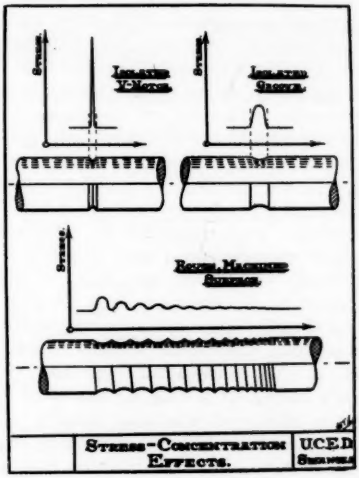

Fig. 6.

local stress concentration differs between a sharp isolated scratch, a single turned groove, and a rough machined surface in which the grooving is in the form of a shallow screw-thread. In the middle of the rough machined surface, the stress concentration is almost negligible, because the stress at the bottom of each groove is relieved by the adjoining grooves. Also, there is no concentration of stress on the right, where the depth of cut gradually runs out. The dangerous section in this case is on the left where the tool has been suddenly pressed into work, and it is likely to be all the more dangerous, because the tool has only just started to cut, so making chips of the "tear" type, which as previously mentioned, are liable to leave behind buried cracks which penetrate some distance into the bar (see Fig. 2). Indeed, as the result of the author's experience in trying to trace the causes of service breakages, he is disposed to suspect that many fatigue failures which at present go

unexplained, may eventually be tracked down to invisible damage unconsciously produced in the process of machining. It is not suggested that this unsuspected damage is *often* inflicted. On the contrary, it is thought to result from some unusual happening, such as say, the work being accidentally stopped or started while a cut is in progress.

Several recent additions to knowledge point to the advisability of making a closer study of the influence of machining conditions on the quality of the surface produced—not merely from the point of view of geometrical smoothness, but from the more searching test of resistance to fatigue. Clearly, a smooth outer surface is of no value in this connection if it merely serves to hide buried blemishes of the nature of incipient flaws which readily form the starting points of fatigue cracks Also, as will be explained later, we now know that a smooth polished surface, free from discoverable buried flaws, does not necessarily offer the highest attainable resistance to fatigue cracking. Some preliminary results on the influence of cutting speed on the fatigue strength of round bars tested in rotary bending have recently been reported by Professors Siebel and Leyensetter[11], The material used was a mild steel which had a fatigue strength of ±22.2 tons per sq. in., when the surface was carefully polished in the ordinary way. Using a depth of cut of 1 mm. and a feed of only 0.03 mm , a cutting speed of about 400 ft. per minute left a smooth unstrained surface which proved to have a fatigue strength of ±21 9 tons per sq. in. Using the same fine feed and depth of cut at a cutting speed of about 70 ft. per minute, the surface obtained was less smooth, and the fatigue strength was some 20 to 25% lower. But when coarser feeds were used, the advantage of very high cutting speed was entirely lost.

Now we reach a strange fact which has an important bearing on how to prepare finished surfaces when the object is to secure high resistance to fatigue. It makes all the difference whether we produce a surface gash by removing material, say with a file or grinding wheel, or whether we produce it by plastic distortion as in the case with a centre punch or cold chisel mark. The former is very weakening, the latter is unexpectedly innocuous. The local plastic deformation neutralises to a remarkable extent the stress concentration usually associated with a sharp notch. Here again, a study of how the fatigue cracks start is informative. As shown in Fig. 7, the file mark starts cracking in the middle where it is deepest, but in the case of the chisel mark, cracking—if it occurs at all—will at first be confined to the extremities of the gash where the plastic deformation is least.

Reflecting on observations of this character led Professor O. Föppl[12] to conceive the idea that possibly the fatigue strength of

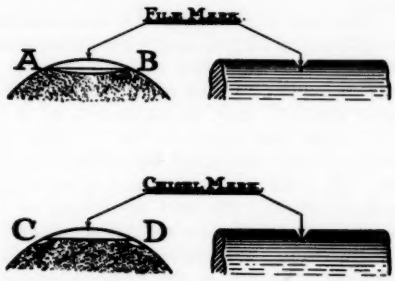

Fig. 7.—Fatigue cracks starting at a notch.

a smooth polished surface could be raised by applying suitably distributed plastic distortion. Using opposing rollers as shown in Fig. 8 mounted on the saddle of a lathe traversed with a fine feed

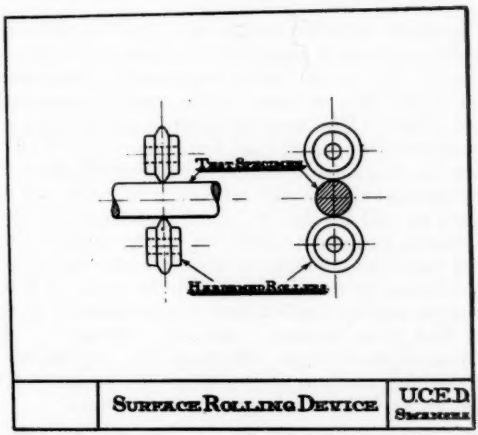

Fig. 8.

as the specimen rotates, increases of fatigue strength up to 20% and even 30% were obtained. Even more striking results have been obtained by rolling the bottom of the threads of screwed specimens.

The beneficial effects on fatigue strength obtainable by surface rolling, which have been made a subject of investigation in the Wöhler Institute, Brunswick under Professor O Föppl for the last seven or eight years, have recently been taken up in Canton, Ohio by Mr.

O. J. Horger[13] who has summarised his conclusions as follows: the fatigue strength of a 0 45% C steel may be increased by surface rolling from 24 to 32%; (2) roller shape has little effect on the increased fatigue strength; (3) the minimum roller feed for about maximum fatigue strength may be expressed by a ratio of roller contact width to roller feed equal to two or greater; (4) the irregularity of surface finish obtained by rolling may be controlled by proper feed; (5) mild heat-treatment after rolling gives 6% additional fatigue strength; (6) cold stretching of fatigue specimens in tension increased fatigue strength as much as 35%; (7) surface rolling of previously coldworked steel does not give as great an increase in fatigue strength as the annealed steel. One of the most interesting figures in Mr. Horger's paper reproduces a series of profile records for various types of surface condition. From this it is seen that the surface does a good deal to spoil the geometrical flatness of the original plain polished surface. Yet the roughened rolled bars offered decidedly greater resistance to fatigue.

Another specially valuable feature of rolling the surface is that it is found to offset the weakening effect otherwise present at pressed and fitted joints, e g , at the inside edge of a railway wheel, where it is pressed on its axle, or where a cone-ended piston rod emerges from the cross-head. The weakening effect at clamped constraints subject to alternating stress has been the subject of extensive investigation at Darmstadt under Professor Thum[14] and it is found to be associated with the formation of much red rust. The slight slipping to and fro due to elastic deformations between the clamped surfaces appears to tear off finely divided iron almost molecule by molecule, which is immediately oxidised with an increase in volume. If the rust is unable to work its way out, the joint becomes so tightly jambed that it is difficult to force it apart. The action has been termed "rubbing corrosion." Researches have also been made at East Pittsburg, Pa., by Messrs. Peterson and Wahl[15] which confirm that rolling the surface of the shaft helps to restore its fatigue strength at fitted joints.

Acknowledgements.—The author wishes to acknowledge his indebtedness to Professor O Föppl, H. Opitz, E. Siebel, and A. Thum for allowing him to visit their laboratories at the Technical High Schools of Brunswick, Aachen, Stuttgart, and Darmstadt respectively. He also wishes to thank one of his research students, Mr. H. T. Lewis, for kindly making drawings for the figures.

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Discussion.

MR. GADD : I would like to congratulate Professor Bacon on his very excellent paper. His work on fatigue stresses is very well known to me and I have followed it with great interest. I do not propose to criticise his paper very much. Actually, I agree with most of it, and should like moreover to corroborate what he has said from the results of personal work at the Bristol Aeroplane Co.

With regard to the question of machinability, I think at the moment it can be safely said that we don't know very much about it. Professor Bacon has collected together some very interesting records and no doubt a great deal of detail work has been done by our people in this country and abroad.

The first thing I should like to say is in regard to the question of impurities in material. I can give Professor Bacon a practical example of that. Even in aircraft work we have often had material from two different sources, both of them clean steel, but one will undoubtedly be much harder to machine than the other, and when we have taken the point up with the supplier of the more difficult steel to machine they have answered that the solution lies in the very clean material they supply. There is something in that, but I don't think it is the whole story. We have examined such materials very closely and the difference in cleanliness may be very small indeed.

With regard to the work done by Robinson and Nesbitt on the microscopic structure of metals, we have done something on that in a small way in connection with machinability of cylinder barrels. Recently we ran into difficulties in machining these barrels and investigated the question of micro-structure, and we finally came to the conclusion there was nothing in it at all. There was no microscopic differences in barrels which were easy to machine and those which were difficult.

Professor Bacon mentioned the fact of work hardening of the metal just in front of the tool. That is a very important point as we who work with very special steels will understand. For instance, austenitic metals which work harden very rapidly are very difficult to machine. He also mentioned that high Izod value has some effect. I do not think that is true altogether because you can get two metals with exactly the same Izod value which give very different machinability.

With regard to Brinell hardness, there again hardness means nothing at all in regard to machinabilty. It depends entirely on the type of metal you are using. In some cases a high Brinell is

useful, in other cases a low Brinell is advantageous. We have had cases where bars have come in with the material in the annealed condition, and the shops have said they were too hard to machine. We have heat-treated them and they have then said they were nice and soft. What they meant was that the machinability was better. Actually, the heat-treatment had increased the hardness.

I have one other point and that is grain-size. I don't know whether Professor Bacon has looked into that at all. About eighteen months ago a metallurgist from a very important steel firm in this country came to our company. These people had done a lot of work in connection with grain-size. They pointed out that if you increased grain-size the machinability was very much better, but the properties of the metal were not so good, but these people have now produced a paper in which they say that grain-size has no effect on machinability. I feel that we have got a lot to learn about grain-size.

With regard to the question of fatigue, we are very interested in that. At the Bristol Aeroplane Co. we have a large number of fatigue testing machines working all the time. The point in regard to the type of crack or initial form of crack which interests us very much is whether it is a circular crack or elongated one, and I wondered whether Professor Bacon has considered whether the form of the fatigue curve shows that in any way. The initial part may be steep or more gradual in slope and it is observed that the material giving the latter form or curve is less susceptible to stress concentration. I wondered whether the form of the crack could be correlated with this feature. With regard to the form of the propagation of the crack further into the metal we, in Bristol, have some special fatigue machines which will give combined fatigue stresses and we have had some very interesting fractures from these.

Professor Bacon also mentioned about the effect of work hardening surfaces to increase fatigue. That work is now well known. I might mention we have made a lot of fatigue tests on nitrided specimens which increase the fatigue strength 20 to 40%, and in those cases the origin of the crack is in the junction of the case and the core and the original form of the crack is circular and not elongated. That is because the material is not so susceptible to stress concentration.

With regard to the question of the marking of the surface and the effect upon fatigue we have had many examples of material being stamped in the wrong position and it is the practice in our works for the designers to indicate the point at which the stamp should be placed. It is very important to have the batch number stamped on every piece, as it is necessary sometimes to reclaim the whole of a batch if something is found to be wrong with the cast. In connection with the marking of material we had an interesting instance of a small connecting rod being marked with an electric pencil for

record purposes and a fatigue crack started from that.

Another point I think might interest Professor Bacon is in connection with surface finish. We had some parts thread ground and it was necessary to treat the parts afterwards by cadmium plating and for that it was necessary to roughen the surfaces. This was done by grit blasting. We made fatigue tests on samples as ground and samples which had been grit blasted and we found that the grit blasted samples gave a higher fatigue strength. The improvement was due to work hardening the surface.

PROFESSOR BACON: I do not think there is any need for me to say much, other than to express my indebtedness to Mr. Gadd. He has devoted himself to imparting information rather than to raising controversial issues. He doubts where there is any connection between machinability and Izod value. I share his doubt, and had overlooked the fact that one of my slides showed a table indicating that there was. In regard to Brinell hardness, the case is rather different. The Aachen chart shows that for ordinary steels, the cutting speed which blunts the tool in sixty minutes under standard conditions can be deduced from the Brinell number. We have to remember, though, that this chart deals mainly with rather heavy roughing cuts and takes no account of the quality of the surface produced. I suggest that a higher Brinell hardness might often help to give a cleaner finishing cut, though the tool would in fact blunt more quickly on heavy cuts.

In regard to grain-size, I think I recognise the paper Mr. Gadd has in mind. It was the revision of views to which he refers which led me to omit all reference to grain-size.

With regard to the initial form of fatigue cracks, I have found this very responsive to stress-concentrations due to surface notches of all kinds; but when using a plain polished specimen, the sequence of contours as the crack spreads seems to be the same for all steels which are in a fit state to use. Personally, I have not made any fatigue tests on nitrided specimens; but I recognise that Mr. Gadd's experience is in general agreement with what Dr. Mailänder, of Essen, showed me some years ago. The cracking of the connecting rod where marked with the electric pencil, and the higher fatigue resistance of grit blasted samples are in line with cases I have described; but are even more striking examples about which I am sure we were all very interested to learn.

MR. DANIEL: There are two points I should like to raise. In the first place with regard to the built-up edge. Is not the accumulation on the point of the tool entirely due to the wrong form of the tool? Secondly, if you get a badly marked piece of metal and machine it so that the original marking is not visible, does not that leave some effect on the strength of the piece?

PROFESSOR BACON: I agree with Mr. Daniel that the "built-up

edge " can be encouraged or discouraged according to how the tool is ground ; but I was under the impression that on roughing cuts at any rate, the built-up edge was often considered to be a valuable feature to retain, as it helped to protect the point of the tool. Mr. Daniel's second question seems to suggest that his own experience favours my suggestion that unexplained fatigue failures may often be due to sub-surface damage, either caused by the tool, or perhaps there all the time, and merely glossed over by machining.

MR. KENWORTHY : In the early stages of Professor Bacon's lecture he referred to the testing of machinability by the Herbert Pendulum. It would be interesting to know to what extent this has been developed in connection with high tensile steels. If there had been any connection between the results obtained by this machine and machinability on these steels I should have thought it would have been in much more common use than it is. It is not much used now, but years ago the prospect of its general use appeared to be very great.

He referred to the method used in Germany of determining the machinability of steel by using a cutting tool for an hour on a particular specimen. That must surely depend on the nature of the steel. In many cases, an hour would be quite a long time for a tool to be in service. Some alloy steels are not machinable by ordinary methods and the only way of machining them is by grinding. It is not conceivable that the application of a cutting tool for an hour can be used in all cases.

The Professor raised a very interesting point with regard to the stamping of components. Mr. Gadd has already mentioned that in very highly stressed parts the design people decide where the parts should be marked. They go further than this and indicate how the parts should be marked. Some parts have to be marked by engraving instead of stamping, or marked by some other method which will minimise the commencement of cracks due to fatigue.

Where the marking of parts for identification is called for by the Air Ministry, they stipulate that inspectors' stamps are enclosed in a circle. This is intended to prevent possible cracks caused by the stamping from spreading beyond the circle.

PROFESSOR BACON : Mr. Kenworthy, like Mr. Gadd, has given some valuable information. It seems to me one does not need to go further than Bristol to meet with very advanced knowledge and practice in regard to these matters. Perhaps this is due to your aeroplane and aero-engine industries, which excel in exploiting every refinement science can suggest. If Mr. Kenworthy will look up the paper by Mr. E. G. Herbert to which I have referred, I think he will find that many of the tests recorded were performed on special steels, including high-tensile and stainless steels. One of

the difficulties connected with the use of the Herbert Pendulum is its extreme sensitiveness. For instance, due apparently to the differential expansion of the different metals entering into its construction, a few degrees change in room temperature has quite an appreciable effect. I agree that for difficult steels a tool life of sixty minutes may be too long to be practical. In the classic experiments of Dr. F. W. Taylor, I believe the standard tool life was taken as twenty minutes. It is interesting and satisfactory to hear how stringent the present-day requirements of the Air Ministry are in regard to the stamping of components.

MR. LUBY : I should like to give my experience with regard to the question of the built up edge. I have found a relatively good finish came off the machine, and on examination we very often detected the presence of a built-up edge on the tool. We have found that when the built-up edge disappears the finish falls. With reference to the cylinder barrels Mr. Gadd mentioned, in some material we got a built-up edge and not so good a finish. It would appear with some materials that if you do get a built-up edge you do get good finish. The built-up edge found in many cases does not seem to do any harm.

PROFESSOR BACON : This is the information I was hoping to get. Perhaps the speaker could elaborate his remarks and give the type of material and the speed of the cut.

MR. LUBY : The material we were using was S.6 steel, and I think the speed of the cut was about 45 ft. per minute. S.6 steel is a medium carbon steel about 40 carbon and about 40 tons tensile.

PROFESSOR BACON : This is not a particularly fast cut and it is in line with what Herbert says. He says the built up edge disappears when you are in the region of 100 ft. per minute.

MR. F. W. PARTINGTON : Not being a production engineer I do not feel competent profitably to discuss machinability, but I am very interested in the methods employed in the speaker's research. Would the lecturer please explain the technique of the machine which stops as soon as a fatigue crack forms in the specimen ; also the method of marking the extent of the crack at various intervals in order to compute the rate of crack propagation ?

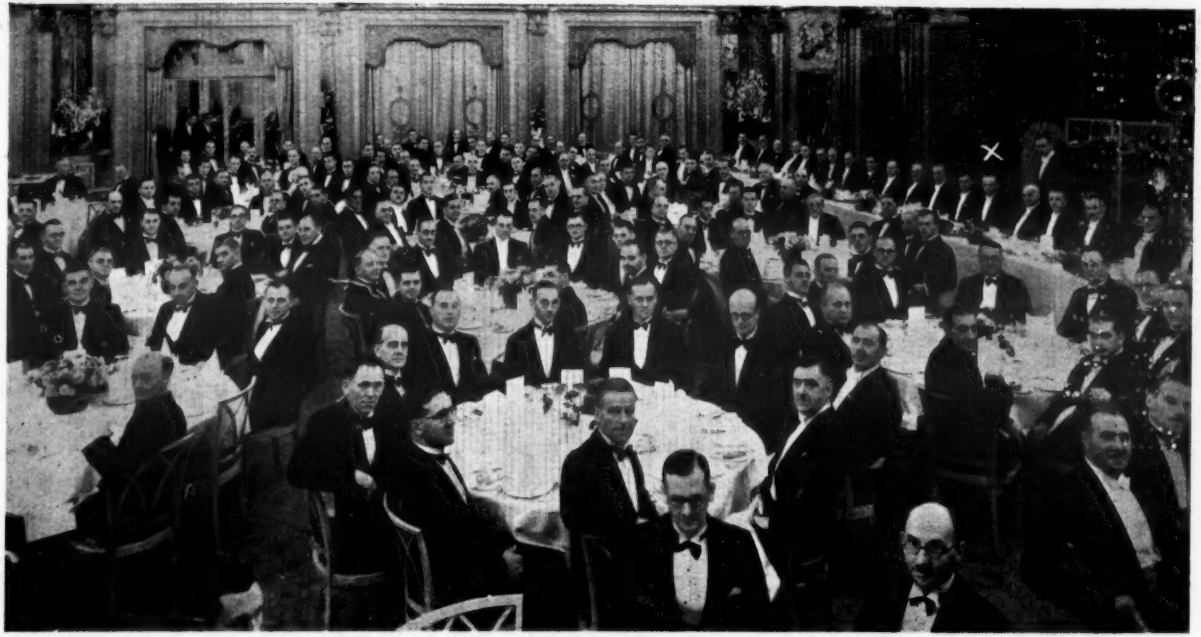
PROFESSOR BACON : I have fitted my fatigue-testing machines with very sensitive trips which can be adjusted to stop the motor if the deflection of the secimen increases by 0.001 in. or even less. Actually, I find it inadvisable to set these trips too fine, as they are liable to function prematurely, i.e., before any cracking has begun. Another expedient I employ is to use specimens shaped to have two necks of precisely the same diameter. Then by the time one neck has cracked sufficiently to operate the trip, it will often happen that the other equally stressed neck will be found to contain a much smaller crack. My third expedient is to stop the machine after a

prescribed number of revolutions, arrived at by a process of trial and error. Thus, starting with several specimens turned from the same bar, I find perhaps that the first cracks enough to stop the machine automatically after say 500,000 revolutions. Then I insert the second specimen, run it under the same load as the first, and stop the machine when the counter shows that say 450,000 revolutions have been run. The specimen is then removed from the fatigue-testing machine and stretched statically in a tensile machine to ascertain whether any small crack has begun.

My method of marking a crack-contour at some particular stage of the crack-spreading period, is to warm the specimen with a Bunsen flame as it rotates very slowly in the fatigue-testing machine. As soon as the outer surfaces begin to tarnish under the influence of the flame, the machine is stopped and the flame taken away. The machine is not started again until the specimen has cooled down again. By this means, the crack is coloured down to the contour corresponding to the number of revolutions made down to the moment when the machine is stopped and the flame removed. Subsequent cracking when the machine is started up again will of course possess the usual metallic lustre. The line of demarcation obtained by this method is very strong and sharply defined. This seems to be because the faces of the freshly cracked crystals are very chemically active and so tarnish strongly at quite moderate temperatures.

MR. ATTWOOD: The lecturer has not mentioned the use of lubricants on the tests in question. We often find that better results are obtained by altering lubricants, but this does not always result in a built-up edge. Take, for instance, the machining of silicon alloy, we have found this to be a difficult material to work, and are often in difficulties when trying to obtain a better finish and longer tool life. A satisfactory lubricant contributes to this end.

PROFESSOR BACON: A practical turner will use anything that will help. I know that lubricants will help enormously sometimes. They say that when you cut at a very high speed there is not very much in it. At Aachen they generally allow 10 to 20% increase in speed due to lubricants. The improvement is partly due to lubrication and partly due to heat extraction. Apparently when cutting speeds are high the removal of heat by coolants is less marked than at lower speeds.



Thirteenth Annual Dinner, May Fair Hotel, London.
X—The President, Lord Sempill.

[*By Courtesy of "Machinery"*

THIRTEENTH ANNUAL DINNER.

THE thirteenth Annual Dinner of the Institution was held at the May Fair Hotel, London, on Friday, 30 October, 1936, Lord Sempill, A.F.C., President, in the chair. The attendance numbered over 200 members and visitors. The toast of "His Majesty the King" was duly honoured.

LORD SEMPILL, PRESIDENT: My Lord and Gentlemen,—Before we come to the first speech I have a very important duty to perform and that is to present certain awards. First, a medal for the best paper last session by a member has been awarded for the paper on "The Relation of Cemented Carbide Tools for Modern Production," by Mr. E. W. Field, past-president of the Birmingham Section, and the late Mr. J. H. Garnett. Mr. Garnett's son is here to receive the medal. Next we have the first winner of the Hutchinson Memorial Medal for the best paper by a Graduate. This goes to Mr. Harry Shaw, of Manchester, whose winning paper was on "Recent Developments in the Measurement and Control of Surface Roughness." This was read by him at no less than eight local sections of the Institution. Lastly, the Lord Austin Prize for the highest attainment at the Graduateship Examination this year has been won by Mr. R. A. P. Mizra of the de Havilland Aircraft Co., who has selected as part of the prize a book called "A Complete Course for Ground Engineers, A, B, C, D, to X," I am sure that Mr. Mizra will have a special round of applause for this selection! Lord Austin is here and it would be very much more of a compliment if he would be good enough to hand the prize to Mr. Mizra.

(*The prizes were then presented*).

MR. H. W. HEALY: My Lords and Gentlemen,—It is a great honour and privilege to be afforded the opportunity of proposing the toast of "The Institution of Production Engineers." I can say without exaggeration that this year it has a significance that none of the similar toasts that have preceded it can claim, for the reason that the engineering industries of the country to-day, no matter where you look have never been in such a flourishing state, and have never shown such a rapid upward trend. If you couple with that the fact that a very large proportion of the expansion of these industries is being applied to the services of the country, it is true to say that at no time in the history of this Institution has the responsibility of its members been so great. In saying that I have regard to the past history of this Institution and a very lively appreciation of the work that its members have been doing throughout the country in attacking those problems

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which are the essence of production engineering. They live and breathe in it.

Perhaps I may be allowed, in a personal vein, to say that the Institution and its members have, in my opinion, one problem regarding output that is never so vigorously attacked as the problem of applying skill to the engineering matter of the moment. Look at all the alibis that production engineers have at hand when they are confronted with the question, "Where is the output?" I have never yet come across an engineer responsible for the assembling of production jobs who will not say, "If you will only give me the bits I will produce the goods"; and if you go to the man who is producing the bits he will say, "I can produce the bits if only you will give me the tools to do it with"; and if you go to the purchase department they will say that there is nothing wrong with the output if only the outside suppliers will deliver the goods and the shop foreman would not lose the papers. And so you can attack every section of production engineering and can find a cast-iron alibi. Now I do seriously suggest to you that if that job of production would be more vigorously attacked all these alibis could be killed once and for all and you will be doing one of the greatest services, not only to the Institution of Production Engineers, but to the campaign that has been launched for the production of goods to a fine schedule during the next three years.

I would like to conclude by saying that I regard this Institution as being one of the liveliest and most valuable of the engineering institutions in the country. It is closer to the immediate practical problems than other institutions and it is dealing with those problems in an excellently organised and spirited way. I place emphasis upon the efforts of the next three years, because that is a matter of very great importance. One may say that this Institution, by virtue of the fact that it has so many distinguished and active members in nearly every engineering organisation of the country under its roof, can provide for the contact between all those members, the pooling of opinion and the exchanging of ideas, and I do not think that anyone can place too much emphasis upon that free exchange of ideas and experience, and of general pooling of knowledge. Gentlemen, I will ask you to arise and drink the toast of the Institution of Production Engineers, with which I couple the name of Mr. J. H. Bingham, your Chairman of Council.

MR. J. H. BINGHAM: My Lords and Gentlemen,—I am proud to have been chosen to return thanks for the good things that have been said of the Institution to which I have the honour to belong, and also to express pleasure for the cordial manner in which you have received them. On behalf of the Institution I can assure you, Mr. Healy, that your kindly wishes are much appreciated. I thought that when this toast was being proposed we should hear

something about our shortcomings, but we have been let off very lightly indeed. I am happy to think that we as an Institution are performing our duties to the satisfaction of the industrial community and those dependent on it ; and in the knowledge of that we should all feel proud. The outlook of the industrial world towards the production engineer has undergone a great change of recent years, and it gives one very much pleasure to come to a gathering such as this and realise that our service is recognised and appreciated.

We as an Institution are a very happy community. A few days ago I read the address given by Professor Cramp to the Engineering Section of the British Association, in which he compared the functions of the pure scientist and the engineer. Of the latter he said, he is the link between human experience and scientific knowledge, and as such he cannot live perpetually in a rarified atmosphere of detachment. He must be in contact daily with humanity and must learn to understand human psychology and human needs. As a result he is less specialised, more balanced, more adaptable, and more understanding than his colleague in pure science. His judgment in human affairs is more developed. Professor Cramp went on to say that a community, or rather a nation, of pure investigators would be calm and peaceful, but as cold as Scotland Yard. He said that an engineer was a good mixer, and that a nation of engineers might be a pleasant community. A very good comparison. To my mind there is no class or type of engineer which those words more aptly describe than the production engineer. Who more so than he has to study the human being, his needs, his aspirations, and his limitations, and who is a better mixer ? Is not the production engineer daily and all day long mixing the elements of machine, material, and man, in an endeavour to obtain a perfect product ? Is not the knowledge of the human element just as essential to the production engineer as that of the other two ? It is ! And how does he acquire it ? In the only possible way—by contacting and mixing with it. That is why in my opinion, the greatest attribute of the production engineer is common sense. It is this characteristic that makes our Institution a pleasant community. There is no " might be." After all, we are only ordinary men. We do not term ourselves experts, but as an expert has been described as an ordinary man away from home I suppose we may be excused if we adopt the title this evening.

Mr. Healy has referred to the national armament programme. I am afraid I must be very careful what I say here. However, whilst the production engineer with the craftsmen's pride, shall I say, prefers to produce things to live and last, rather than things to destroy and to be destroyed, he knows just as well as anyone else that the lion and the lamb may lie down together, but it is only the lion that gets up. I am confident, therefore, that since

national needs demand it, we production engineers will give of our best, of a best that will be better and worthier of our calling than even the high standard set by our predecessors in the fateful years of 1914-1918 when ours was not an organised profession.

As Chairman of Council, I cannot let this opportunity pass without saying that though the work of Council may be arduous at times, it is with its members a duty, a labour of love, and not a virtue. We are proud of our Institution, and we are prouder still of the fact that you have signed us on as a crew to work under such an able navigator as Lord Sempill. In Council or in Committee, though we may make minutes we do not waste hours, for our General Secretary, Mr. Hazleton sees to that, and it is here that I would like to pay tribute to his ability and expert assistance.

One of the valuable results of the work of our Institution is to give to the production engineer a higher professional status and a more conscious professional outlook, and to help him realise more keenly his own important strategic position in the scheme of things. The presence of so many distinguished guests at our table to-night is proof sufficient that that work is being recognized.

LORD AUSTIN, K.B.E.: My Lord President and Gentlemen, May I, before proposing the toast of "The Visitors," which it is my pleasant duty to do to-night, thank you all very much for the extremely cordial manner in which you have received me? I consider it a very great honour to receive such a warm welcome, which is made all the more pleasant by the fact that I am among men many of whom have grown up with me. I feel as though I am within a family circle and one of that circle.

We are honoured by having with us to-night many distinguished guests representing a wide variety of important professions, and I should like on behalf of the Institution to extend to them a very hearty welcome.

I do not intend to deal too long with the duties of the production engineer. The time is short and other speakers have told you something about his activities, and no doubt by now you are fully appreciative of the efficiency and genius of the production engineer! I am assured by the General Secretary, however, that we have not yet enrolled the parents of the Dionne Quins!

I think it is necessary that the world should be reminded of the part the production engineer plays in everyday life, and that people should appreciate the fact that a great number of necessities and luxuries we enjoy in abundance and at a reasonable price are made possible by his resourcefulness. In the organisation turning out new products in large quantities he is a very busy man indeed, for three main activities come under his jurisdiction—technical application, employment control, and costing. I mention these facts in order to let our visitors know that a production

engineer is a very important individual in the scheme of things. I can assure you I am very proud to be a member and a Past-President of this Institution.

We had hoped that Mr. McCann, the Agent-General of South Australia would be with us, but unfortunately he has been unexpectedly called out of town. We hope in the near future to form a branch of the Institution in the Commonwealth, and I am sure that the strides engineering has made "down under" warrants such a move and that a thriving off-shoot will result. For me the project has especial interest, as it was in Melbourne, Australia, that I served my engineering apprenticeship.

I am also glad to know that amongst our guests is Colonel Disney, of the Air Ministry, because I doubt if there is anyone in England to-day more intimately concerned with production efficiency. He realises, I am sure, the vital part the production engineer will play in carrying out the scheme for building England's air defences.

We are also delighted to have with us two other distinguished members of the Air Ministry—Colonel Outram and Air-Commodore Hierson. Colonel Outram is responsible for that very important activity, inspection, while Air-Commodore Hierson deals, I believe, with the small but extremely vital details of planes. Though small, no doubt, they present their full share of trouble and difficulty.

I am also very pleased to see that Mr. Bartlett, of Vauxhall Motors, has been able to come along. I am sure that we extend to him a very hearty welcome. I am sorry to say that Mr. Watson, the President of the Institution of Civil Engineers, who was to be with us has been unable to attend due to his recent bereavement through the death of his wife, and I am voicing, I am sure, your sentiments when I extend to him our very sincere sympathy. We hoped to welcome to-night Mr. Lightbody, the President of the Cost and Works Accountants, but unfortunately he has had to undergo an operation. I am sure you would like me to convey to him our wishes for a speedy recovery.

We are also pleased to have with us a distinguished member of the Irish Free State, the Rt. Hon. James MacMahon, a Director of the Southern Railway. Though engineering is not yet a principal interest in Southern Ireland, it appears that the Free State Government is determined that it shall be, for recent legislation has made, amongst other things, the importing of motor cars from Great Britain a very complicated business. This is not the time to discuss such a complex subject, but perhaps Mr. MacMahon will take from this gathering a hint that if the import duties are to be continued we hope they will not be made more restrictive than at present. Firms like my own have had to arrange for assembly factories over there—anything but an economical proposition with market possibilities as they are. I can assure you it has set

British production engineers, and also motoring agencies in the Free State, a very difficult problem.

Though a production engineer has been a dominating force in industry for many years, especially during and since the Great War, the special efforts that the Government are making on the rearmament plan are going to test his abilities and extend his work still further. During the next few years he will be a very important unit indeed—in fact, a great national asset.

I have often heard the suggestion that the production engineer has progressed too fast, that he has outstripped the general economic advance, and no doubt there is something in this contention. We know, for instance, that the ordinary manual costing methods long ago ceased to be sufficiently rapid to cope with modern industrial requirements, and so the engineer has to take a hand in the matter with the result that mechanised costing and accounting came into being. Perhaps he will eventually have to settle the economic position, too.

We are living in an age of plenty, when goods can be produced in great quantities, cheaply and well. The only thing missing is the power of the people to consume, an inability caused by the lack of a medium wherewith to purchase. This is a sad reflection on our economic system.

I do not think anyone can accuse me of being a red-hot revolutionary but I do feel that the logical conclusion to be drawn from the foregoing facts is that our economic and political system is not sufficiently plastic to cope with modern conditions and rapid industrial progress.

In engineering, when we find a better and more economical way of doing a job, we scrap the old methods without compunction, and I am confident that our political economists will have to work along similar lines. Many of the moves would at first meet with strong opposition but the results would have to justify the steps taken.

I am sorry that I have digressed from the original purport of my toast, but I hope our visitors will forgive me. Perhaps the few remarks I have made will give a lead to some of those engaged in other branches of national activities, and urge on an economic reform which will make the work of the production engineer still more beneficial and useful to the peoples of the world.

Before I conclude I would like to show my appreciation of the work that you have done within the Institution of Production Engineers. I am afraid I had not as much to do with the founding of the Institution as your Chairman has suggested, though I did something towards helping the Institution along in the early days. I have never regretted that. I wish that I had been able to do more, but I would like to show my appreciation of what has since

been done. I believe, from what I can gather, that the Institution has made more solid progress than any other organisation of its kind in the country. For this there is a very good reason, namely, the work done by those belonging to the Institution—the Members of Council, the local Committees, the General Secretary, and the other executives. I would like to present to the Council of the Institution the sum of 50 guineas to promote the work of the various local sections during the coming year.

We are most honoured and delighted that so many distinguished guests have been with us to-night, and I would ask you to rise and drink the health of " The Visitors," with which I couple the name of Mr. A. Binns, the Chief Engineer to the Port of London Authority and President of the Institution of Engineers-in-Charge.

MR. A. BINNS: Mr. President, Lord Austin, and Gentlemen, an expression of regret has already been made at the absence of my esteemed friend, Mr. J. P. Watson, the President of the Institution of Civil Engineers. He was to have replied to this toast to-night and therefore I have specially to regret his absence, and, as Lord Austin said, our sympathies go out to him for the great sorrow which has recently befallen him.

On behalf of the guests I would like to acknowledge the good fellowship which you have shown to us this evening, and I should like especially to say how much we appreciate the fine speech of Lord Austin in which he has proposed this toast. He has given us much food for thought. He also made extremely kind references to many of us who have the privilege of being your guests, and we appreciate the very hearty way in which you have drunk to our good health. It is not everywhere that people go through this ritual of after-dinner speeches. On the Continent it is not practised to the same extent, and as you go further east and arrive at the oriental countries I am told that the only expression of gratitude for a very good dinner is often those internal regurgitations which we are taught to suppress as far as possible. Now, we have been taught to say grace after meat followed by " Please may I get down," which in my case should be " Please may I sit down." Of course, it is not good form to talk about food. We have all been taught that. Even your guests know that. It is not everybody that knows it, for the French talk a great deal about it. They write books about food, and I do not quite know why it is such a crime to talk about it. After all, it is a matter which vitally touches every one of us to the innermost parts of our being. I appeal to my fellow guests. Have you never suffered the inconveniences of being without a cook? I appeal to you even more confidently, have you never suffered the inconveniences of not being without a cook? How often our Sunday joint has been offered up—a good engineering phrase—as a burnt offering or as an underdone

sacrifice? I am quite certain that some of you would have used a more sanguinary word. But you must remember that I have the honour to be the Chief Engineer of the Port of London Authority and in the Port of London we have the most wonderful vocabulary, which is only partly known to sailors, and of which the editors of the Oxford Dictionary have no conception whatever.

Now, gentlemen, I am here really as President of the Insitution of Engineers-in-Charge. That is an enigmatical phrase—is it not?—almost as difficult as production engineers—engineers in charge. I noticed that Mr. Healy spoke of the alibis that you have to establish and Mr. Bingham later on made some references to Scotland Yard, and I do not know whether I should be in order to ask if and when you are taken in charge?—you are usually described on the charge sheet as a production engineer. Of course there are many other institutions besides engineering institutions. There are mental institutions, and there, I believe, people are taken in charge. I remember hearing of a distinguished visitor at one of these mental institutions who was asked by one of the inmates, "Do you know why we are all here?" He got the answer in the negative, and then came the crushing explanation, "We are all here because we are not all there."

May I say that you are production engineers and, I suppose, that really I am a distribution engineer. Production and distribution. These words together raise some sort of echo in your minds, and it makes me wonder, supposing at this moment we were raided by one of the political leaders. Imagine him coming in at these doors supported by innumerable followers all armed with spare shirts, of the appropriate colour, and copious doses of castor oil. Just imagine the means of production and distribution captured at one fell swoop!

Your general secretary was good enough to tell me that your membership is increasing and that you are prospering in every direction, but I rejoice more still that your production has been increased. I know that it is increasing because in the Port of London Authority we have to try to satisfy the unsatiable demands of about 20,000,000 of you for raw materials, and we have spent 17,000,000 sterling in extensions, and we have now a programme of another 12,000,000 in front of us, all in the endeavour to keep pace with the demands made by you people who insist on ordering things from overseas and exporting your finished products, and we are most anxious to help. We are going to spend this £12,000,000 in absolute confidence that you are going to carry on with ever accelerating production.

Now, I have been delighted to notice quite a considerable number of young men here to-night, some of whom are presumably graduates. I notice that in the programme for the coming session that the title

of one paper is "What the Graduates should know." I have great sympathy with these graduates, and I am delighted to see some of them here tonight and to know that at any rate they are having a little refreshment by the way. So cheer up with the knowledge that your reward is sure to come. At present you know the absolute necessity of hard work, and that reminds me of Sir Alfred Newman's book "The Outlook of the Engineer." If you have not got it, you graduates, you ought to read it. If you are getting on too fast it will chasten you. It will give you a bigger outlook. On the other hand, if your genius is unappreciated and the rewards tarry, it will cheer you up in the struggle that you have before you, and that reminds me of one other thing, and that is, I think, that the greatest virtue you graduates can cultivate is courage. If you have not courage it is no good. The finest address ever written, in my opinion, on courage is the address given by Sir James Barry to St. Andrew's University. You read that.

Now, the libel has been thrown at this Insitution that you are slaves of your machines. One of your speakers referred to machines, materials, and men. I am not sure that you ought to put men in the third position and I am quite certain that you production engineers who are doing so much to increase the leisure of the whole community, I am quite certain that it is your duty to educate that community to use these leisure hours to the best advantage.

Well, I am afraid I am getting too serious and too long. I would like to say on behalf of the guests once more, "Thank you very much." You came out to the highways and byways to find us out. We came in. You have treated us very well. Ask us again. We have discovered anew something which I can best express in the words :—

Hearts just as pure and fair,
Beat in the Hotel Mayfair,
As in the lowly air
Of Seven Dials.

MR. E. C. GORDON ENGLAND : My Lord President, my Lord, Gentlemen, I find myself in a very awkward situation. As you know, I should propose what is always the most enjoyable toast I think anybody can be entrusted with. But your President unfortunately telephoned to me a little while before I was dressed for this evening's gathering, and said, "Mind you don't say anything about me." Well now, how can you propose the toast of your president without doing so ? I propose to earn yet another black mark, of which he no doubt has a number already chalked up against my record for disobeying his instructions. But before I do that, I think I ought to get level with him to a small degree by asking him a few conundrums. I mean these very seriously, and I am sure it will give him an opportunity to reply in his own inimitable style, and I shall

look forward with great pleasure to his answers.

An institution such as ours, as you already heard this evening, carries an immense potential responsibility—a responsibility which, if it is mishandled, can become immensely dangerous, that is the power that lies behind it, can become an immense potential source of evil. Properly handled it can become an immense and valuable servant to the community, and this Institution has, I think, been extraordinarily wise and shown exceptional wisdom since its beginning in realising perhaps only to a small extent, as we are very seldom able to realise the true power that lies behind any organisation, but it has realised it in part, that there is danger of us becoming too narrow, the danger of seeing too much of the trees and too little of the wood. This knowledge has caused our council from the beginning to strive to find Presidents with breadth of outlook and entrusted the steering of this very valuable machine to those people who, including our President, have watched over our Institution and it is wise that it has been so.

What is this production which we are always talking about? Its manifestation is the production of goods, but that, after all, is not what we are striving after. Fundamentally we are striving for a full life and that is the tremendous potentiality which lies in the hands of the production engineer—the power to afford all his fellows a full life. That being so, you are not, as Mr. Binns has so well put it, dealing first with machinery and then materials and lastly men, you are dealing first and last with men. That is our great responsibility—the great responsibility of this organisation—and that is the responsibility which our President has been carrying on with such credit to the Institution and such distinction to himself. We have to consider this problem of our real purpose and I throw it out to you, Mr. President, is it not time, and perhaps even now it is in the thoughts of the Council of this Institution, that we should take a more definite step towards that end. That is, realise more clearly the real purpose of our Institution's activities. Let us see the wood and a little less of the trees as our objective and I put it to you that perhaps along that line there lies a work for this Institution.

At these times, as other speakers have already dealt with so well, the country needs our efforts more and more for the vital purpose of defence, and if I may just digress for one moment, I spent a most uncomfortable one and a half hours last night listening to an address by that most distinguished foreign editor of *The Times*, Mr. Wickham Steed. He is a man who, as I think you all know, is a specialist—I use the word advisedly: I hate the word "expert"—he is a specialist in foreign affairs, and the subject of his address to this select gathering was the question of "Can we Avoid War?" and I regret to say that he left me truly

depressed. Let us hope that he is wrong. Being an extreme optimist I somehow feel he is wrong, but so serious is the situation that the country does need to put every effort forward at this time to put us in a position to prevent war, if we take what I believe to be our correct place among the nations. The position is extremely serious. Is there not something that this Institution can do, shall I say to assist the Government in many activities? The Institution has much wisdom within its membership which I feel is being unused at the present time by the authorities. Is there nothing which we might do in that sphere?

Then, gentlemen, it does not need me to tell you that there is facing us a great problem and that problem is the attitude, the temper, and the aspirations of, what is generally termed Labour, to-day. Labour is undoubtedly in a frame of mind which to a production engineer is very ominous. I myself, like so many of you, probably read the publications that circulate among the workpeople. I read them regularly. I am not concerned with the men's political views—every man is entitled to have any view he likes—but what I do deplore is the fact that they appear to have no ideals in these journals which circulate amongst the men. They are just one continuous stream of anarchy. Now I think that is the most desperate and dangerous position into which any great group of people can be led, and that is what I find expressed throughout all those publications. I think there must be many of you here who agree that that is what you draw from reading their publications. There is no facing of realities, no aspirations or ideals, they just tear down and destroy. The very antithesis of everything for which this Institution stands. Here again, is there not something which we can do? Is not there something we can do, perhaps with the leaders of the men? We call in heating engineers if we have a heating problem and electrical engineers if we have an electrical problem. We know that their advice may be biassed and interested but that does not prevent us from consulting them. Can we not adopt a somewhat similar attitude towards this labour problem? I leave the suggestion at that. These are three points and there are many others that one could bring up in the wider sphere of our Institution's activities, but I think nevertheless they are the most important, and perhaps our President would care to address himself to them.

And now, having given him three conundrums to deal with, may I just for one minute address myself to him, and I know that I stand out of order. The President and I are very old friends and I have a very great grudge against him—that is that when I met him the first time, right way back in 1914, he looked the picture of health and youth, and energy, and, though you may not believe it, he and I are very much of the same age, but look at the difference

between us now. He retains all his youth, figure, and good looks, and I am fading into the background. But seriously, gentlemen, your President is a most remarkable man with a very distinguished career. I am not going to labour what he has done in other spheres because his life is a public one and is known to most of you. I think the great charm about him is that whatever he takes up he takes up with that whole-heartedness and disinterestedness, and with that finest attribute, a real desire to serve those with whom he is connected, and from that we all get inspiration. It is an inspiration to be a friend of his ; an inspiration to be a co-worker with him, and one feels when with him that drive to achieve something for the good of the community—a very noble character descendant of a very noble family. Gentlemen, please raise your glasses and drink with me whole-heartedly the toast—the health of our President, Lord Sempill.

LORD SEMPILL : Mr. Gordon England and Gentlemen—I am very proud and happy indeed to be with you all to-night, and always proud to be at any gathering where production engineers assemble. When you look at my very good-looking friend who has just sat down it is hard to imagine that about twenty-seven and three-quarter years ago he set on foot in this country a plan of progress in flying that is now being carried on with such effect to-day by such people as Lord Austin, Colonel Disney, and Colonel Outram. We can hardly imagine that Mr. Gordon England has been a pioneer in this new phase of transport and new defence arm of the country to which the press are turning so much attention at this moment. On your behalf, I thank Lord Austin for the gift of 50 guineas that he has given to the Council with the wish that it has to be used in the interests of our Institution.

Mr. Gordon England has indicated to us the duties and responsibilities of the production engineer and the need for qualities of a very high order if he is to meet the demands of to-day. The moral to be drawn from what he has said so far as the production engineer's Institution is concerned is the need for vision and foresight on the part of those who guide its destinies. Ours is a very young Institution and one of which too much cannot be expected as yet, but there is no doubt that we will be judged by the approach which we make not only to the problems of British industry, but also to the highly important problems with which the state itself is confronted, which have been referred to to some extent to-night. As an Institution, we make no claim upon industry and no claim upon the State. The last thing you would desire would be to interfere in questions of policy with the one or the other, but we do want it to be known by both that our organisation contains within its ranks the leading production engineers and experts in the country, and that it is anxious to serve industry, and the State by discharging to the best

of its ability any duties that it may be called upon to perform. I am glad to say that already we have been made use of by certain departments of State, including the Committee of Imperial Defence. I have not the least doubt that much more could be done in that and in other directions, provided we make it clear that we are not animated by a feeling of self-importance or self-seeking, but by a single-minded desire to render service to our country.

A year ago, as you will remember, Mr. Gordon England stressed the fact that our Institution and its work are not well enough known. That is still true. It is only gradually that a handicap of that kind can be overcome. Every year the work of the Institution is becoming known to a wider and wider circle. It is steadily gathering strength and influence—last year was a record one in the number of new members that were enlisted.

Those suggestions that have been put before us to-night by Mr. Gordon England will certainly be thought over and acted upon so far as we can act upon them. You will all wish me to thank him very much indeed for his address. We realise that he is himself one of us and also a real pioneer in those fields of industry that have been rendered possible by the modern day advance of engineering. I thank him for his very useful reference to the Institution, and in so far as his personal reference to myself is concerned, that is a matter that will be taken up at another time and in a different place.

I should like to take this opportunity of saying how much I value the splendid work of the Chairman of Council, the Section Presidents, and the Section Committees, many of which I have had the privilege of visiting, and of everybody connected with the working of the Institution, particularly my very good friend and unfailing guide, Mr. Hazleton, who is ably supported by Mr. Marsden, our Assistant General Secretary, and by an active Staff at Headquarters. You will all agree that the arrangements for our comfort and enjoyment here at the May Fair Hotel to-night have been admirably carried out, and I am sure that we will look forward with much pleasure to future gatherings here on similar lines.

A LETTER TO THE SECTION PRESIDENT.

Paper presented to the Institution, Birmingham Section, by R. H. Youngash, Member of Council.

Dear Mr. Edwards,

EARLY in March the hedges were breaking forth into tender green, and England, this England of ours, was showing promise of the spring so glowingly described by our poets, when I (with somewhat mixed feelings) set forth on a journey to the other side of the Atlantic. One thing in particular gave me a feeling of uneasiness—the knowledge that in a moment of weakness I had already pledged myself to tell you something of the things I should see, and in this letter you have the fulfilment of that promise. I am, however, very anxious to avoid giving you, in the slightest degree, any idea that I am to be considered as an authority on this subject or that this is anything more than a record of my own personal impressions.

Most of the people I came in contact with were friendly, kindly disposed, and very hospitable ; they do not, as a rule, talk the language of the films, they do not wear horn rimmed spectacles, and they do not all perpetually chew gum. I saw very few people actually using the latter, but the fact that the largest electric sign in the world advertises it, and that under the rim of hotel dining tables is one of the favourite parking places for used portions of this commodity, leaves no room for doubt that it is used to some extent.

I suppose all human nature shows its peculiarities in different ways and I found it interesting to hear our own King always spoken of as *The King*. Also they speak of Roosevelt, Al Smith Edison, and *Mister* Ford. Why this fine shade of distinction I do not know, but they eat, drink and smoke and are good fellows and nearly always explain that in some mysterious way they are directly or indirectly connected with England.

I could write at length of the interesting points about their cities, but fear your patience would not last out. I must say, however, that New York is a wonderful place, and everyone who can, should, make an effort to visit it, and see the buildings, bridges, tunnels, roads, and so on, which probably have no equal in the whole world but the absence of buildings with the dignity and grace of the old ones in this country is particularly noticeable. This also applies to

their houses, which are generally built of wood. They are remarkably convenient and well appointed, but the mellowness and charm present in many houses here is entirely missing.

It must not be inferred, however, that they have no beautiful buildings, because some of their show-places such as their museums and churches are really fine examples of architecture, and in them they have some of the most valuable exhibits to be found anywhere in the world. It should be particularly noted that some of the towns, taken as a whole, are really very nice. Generally, however, there is a severe utilitarian atmosphere in the design of all their buildings, and the layout of the towns in rectangular squares, however convenient, produces a box-like effect which seems a little too mechanical.

I feel I ought to record the air of " go aheadness " that was evident in all the works I visited, although the depression through which they are passing has somewhat chastened their aggressiveness, and empty factories, warehouses, and shops show that recovery is by no means complete ; yet there is a spirit of eagerness and determination that makes itself felt everywhere one goes.

With this in mind I wondered what was their attitude toward a subject we have discussed at some length, " The Economy of Plant Replacement." It would appear that the *American Machinist* has been examining this problem and has put on record that 65% of the plant used in the twelve main districts in which investigations were made, is over ten years old, while in one particular district the figure went up to 83%. Two examples will show what this means. Out of a total of nearly 30,000 capstan lathes, over 20,000 are ten or more years old, while out of a total of 127,000 engine lathes, nearly 95,000 are over ten years old. These figures may not convey an accurate impression of the whole picture, because the motor car industry uses many special and single purpose machines and changes of method necessitates new plant at frequent intervals. This tends to reduce the average length of life, but it does indicate that, shall I say elderly machines, are not unknown over there, and an interesting comparision is the fact that a similar census taken in 1925 shows that at that time only 44% of the totals were over ten years old, and in 1930 the figure was 48%, while in the present census, made in 1935, the figure, as I have already mentioned, is up to 65%.

Well, Mr. Edwards, those are the facts, but perhaps you would like to read what they *say* about this matter. For this purpose I am quoting from an address given by a gentleman who is Vice-President of a firm of management engineers. He says, " Obsolescence is a disease which can ravage not only plants, but practically everything which is of a contemporaneous nature and if we devote some time to it and really study the matter, it will be appreciated that nothing

is so prone to become covered with the mildew of obsolescence as an idea. I would like to suggest to you that businesses die from the top, just as with the tree the top is the portion which naturally first feels the rain and sunshine, so it is the first to feel the draught and the blizzard." He then goes on to say, " In preparing my address for to-night I had one mission in mind, and that was to draw your attention to the fact that obsolescence should be looked for in all quarters and not confined in any way to plant alone. Like the bugs of influenza, obsolescence is with us all the time, and it only waits for the weakening of one section of the corporate structure to strike and get in its deadly work, so all of you, presidents, general managers, plant managers, sales managers, research directors, chief engineers, personel directors, superintendents, and foremen, remember that no department of the business, even though it poses as Cæsar's wife, is above suspicion when obsolescence of ideas roam abroad."

May I add that if you can find any comfort from the soul searching self examination advised by the writer of this paper, I should be glad to share it. On the other hand, if you have not already done so I strongly advise you to read the article published by the *American Machinist* in April, 1935, which says, among other things: " It indicates that, at present, industry is more poorly equipped to manufacture metal products than at any time since the start of the world war." And in another place: " New machines cost money. But continued operation of old equipment after its economic life has passed may cost a great deal more. Hundreds of shops have paid many times over for equipment which they did not buy by insisting on housing mechanical relics that should have been retired."

Like most good pilgrims, I visited some of the motor car shops, and was duly impressed by the almost unbelievable size of them, but you will have read in the technical press at various times quite sufficient to relieve me of the necessity for any descriptive effort. Many of the operations I watched were performed in an astonishingly short time, and while I suppose no finality will ever be reached, it is very difficult to see where improvements could be made. The pressing of a dished cover used to mask the wheel hubs was a good example of rapid production. The material used is steel about $^1/_{16}$ in. thick and is supplied in coils. There are 12 operations and the whole series are performed in one press which has 12 sets of punches and dies in line, the whole process being continuous. The time per piece is something like fifteen seconds.

Another example was stamping 175 motor car front axle beams per hour, the work being accomplished in a powerful press and not a drop stamp.

In another works there is a comparatively new process for removing scale after hardening. This is an electrolytic pickling

process, but differs in the fact that during the operation a thin coat of tin is deposited on the surface instantly the bare metal is exposed. This coat of tin prevents further acid reaction on the descaled surface during the removal of the remaining oxide, and it would seem possible to leave delicate articles in the acid bath for an indefinite period if necessary. Where an alternative to shot or sand blasting is required this process has much to recommend it.

I am of the opinion that extraordinary care has been taken in the design of every component part of their cars to ensure that the least possible amount of time must be expended upon making it. This may appear a very simple statement, but I feel certain that much more thought is given to the processes involved in producing the part than to the part itself, with the result that many operations which we here would consider necessary are avoided altogether, and those that are performed are comparatively easy. This, I venture to suggest, is one of the reasons why American cars are sold at low prices. This point leads me to a little digression. You can buy a popular car over there for about £120, and so you can in this country for that matter ; but there is considerable difference in the cars ; the American is a good sized car, with an engine developing 60 or 70 b.h.p. while here you get a small car with an engine of say 15 b.h.p.

These facts are, in themselves, not of very great importance, but what I do want to call your attention to is that, whereas the English car costs an average workman something like thirty weeks wages to buy, the American costs less than fifteen weeks wages. I think you will agree that this point leaves room for considerable thought, and explains why almost everyone rides to work in his own car.

It is interesting to note that in any given works enormous care is taken to preserve an unbroken flow of work between the raw material and the finished product, and yet steering gears may be made 70 or so miles away from the main works and gear boxes perhaps 500 miles away.

Another item I should like to mention was an elaborate gauge or machine for examining camshafts, which examines every important point automatically. It is housed in a specially built chamber where a constant temperature is maintained and is a very clever piece of apparatus. At the time of our visit practically the whole of the shafts coming through were being rejected. The rejected shafts were then examined by a man who considered that they were usable and who passed them out to the assembly track. After all, why not ? If the shafts could be made 100% perfect, why examine them ? And if the gauging mechanism can only pass 100% perfect shafts there is bound to be a large proportion of rejects so long as fallible humans have to produce them. With these examples in

mind I venture to ask who would be dogmatic as to what is best ?

Many American factories have plenty of room in their shops and around their machines, although they are situated in comparatively crowded districts. On the other hand, one large producer has hundreds of acres of land around his works and the plant so closely jammed together that it is almost impossible to get among the machinery at all. It would seem that the only explanation is in the saying we all know—" He who pays the piper calls the tune."

And now a few lines about the machine tool trade. Speaking broadly, the shops I was able to visit were very much like those in this country, some were storied buildings, some a series of patches, and others were of modern design and all on the ground floor. To my way of thinking there is considerably more specialisation there than here, and many firms are building only one line of machines. This has of course obvious advantages, and, I suppose, has some effect in avoiding too much competition for similar types of machinery.

I did not see any evidence that their organization is in any way superior to ours but I am quite sure there is much greater co-operation and more pooling of information, both scientific and practical, than we are accustomed to here.

There seems to be no doubt that the motor car industry is very largely indebted to the machine tool trade for the progress it has made in recent years. The general practice is to put a problem up to a suitable firm and accept their recommendation, while the motor firm give all the scientific and metallurgical help in their power as their contribution, and so, in a works devoted to gear cutting machines, you could obtain latest information regarding the physical properties, the grain size and the chemistry of the steels used for this class of work, and, further, this information is available to anyone interested irrespective of whether he uses that particular line of machines or even makes gears. One motor corporation spends nearly a million dollars a year in maintaining a large research laboratory and most of the results they obtain are available to the machine tool trade. One matter receiving special attention is machinability, and they hope to arrive at some conclusion which will eliminate the difficulties caused by variations which cannot be discovered by either Brinell or Rockwell Tests.

The fact that American firms are generally able to build large batches of machines must have considerable influence on costs, but as a set off against this labour charges must be practically double what they would be here.

There was very little evidence of anything novel or very new coming along. Many of the shops were fairly busy principally on orders for Russia. The motor shops generally were taking a relatively small amount of new plant, so far as could be seen. A considerable

amount of re-building and converting was being carried out by firms who, I imagine, are glad to undertake this work to help to keep going.

Cemented carbide cutting tools did not seem to be used to quite so great an extent as here, and while many machining operations are spectacular, the results were obtained by multi-cutting points rather than exceptionally high speeds, in most instances.

I am of the opinion that the standard finish of machine tools generally has deteriorated of recent times; this however, does not affect accuracy, and I saw no reason to suppose that in that direction America is not keeping pace with the rest of the world.

An interesting side issue is the fact that there is considerable sale for small machinery suitable for amateurs, such as drilling machines, lathes, and many varieties of woodworking machines. These are, generally speaking, quite serviceable tools, usually equpped with a self-contained motor drive and a very big improvement on some of the machines sold in this country for this purpose.

I am afraid you will be getting tired of this already somewhat lengthy letter, but even at the risk of boring you, I should like to write something of more general matters.

I realise quite well that I could not expect to understand but very little about another nation in the short time at my disposal, although their language is the same as mine, so that whatever opinions I have formed, you will please remember that they are purely my own—perhaps I ought to say peculiarly my own—and accept them for whatever they may be worth.

There seems to be no *Nation* in the sense that we understand the word, and an American citizen may have descended, in perhaps only one or two generations, from any nationality under the sun, and so I was unable to discover but very little of what might be called a National Outlook. In fact, Individualism seems to be the predominating characteristic.

This suggests a reason for many things we do not quite understand. There seems to be very little public opinion on matters of national importance, outside a few classes, nor is there much interest taken in civic or municipal matters except by a few interested parties. There is disregard for the state laws in many ways, such as a general belief that one can avoid the consequences of almost anything, providing a plentiful supply of the almighty dollar is available, and at the far end of the scale you have the familiar gangster who breaks most laws.

I heard several times how much the British legal system was admired, and they appreciate the fact that our own judges and law officials cannot be bribed.

It would seem impossible if my thoughts are correct, for any of the modern " isms " which so badly afflict Europe to take root in

America. The strong sense of individual liberty should be proof against any form of, shall I say, " Collectivism," yet the association of ideas, and the mass attraction of peoples for each other, is so great, that no nation under the sun could be fonder of Conventions, Societies, or Orders of This and That.

All this, however, is merely a part of the American liking for things on a big scale. Enormous undertakings in civil and structural engineering, irrigation, railways, and so on, are quite ordinary and common.

It must be remarked, however, that it is a country of extremes. Even in nature you have well marked extremes ; temperatures, for example, will range in New York from 40° below zero to, say, 90° in the shade. The extreme heat of the summer is no doubt the reason why their buildings, factories, hotels, and homes, are kept at what we should call a very high temperature during the winter, something over 70°. Even their cars are invariably fitted with some form of heater.

You will, of course, know something of the famous sky-scrapers, buildings of almost unbelievable size. There is considerable justification for the erection of these wonderful buildings. The most important part of New York consists of a narrow peninsula which cannot be enlarged, so upwards was the logical way of expanding. Nature had provided a magnificent natural foundation on which to build and the only problem was how far up could one go. Whether the present—some 1,200 ft.—represents the limit I do not know, but probably not. There is however, not the slightest reason why other towns should do the same, but have them they must, not quite so large, not quite so high, but the urge to imitate demands skyscrapers as often and as large as possible, but if you examine a small town, or what we should call a country village, you will find that incredibly primitive conditions exist, not only in the building, but in the general conditions of the inhabitants. As I mentioned before there are such well marked extremes.

You would be interested in their railways. In the big cities there are magnificent stations, far larger than we have here, but in small towns the stations will not bear comparison with even the poorest we are accustomed to. Their locomotives are extemely ugly and awkward looking, they seem to have put every possible obstruction in the way of air resistance, but their latest efforts in " Streamlining " go much further than in any other country. Their tracks or lines are laid without " chairs " and the rails seem to be held in place by 6 in. wire nails ; level crossings are mostly unprotected and they have thousands of them ; in some cases the main line runs down the centre of a town exactly the same as in the case of tramcars here. It is very common to see rail tracks crossing each other at right angles and on the same level, and I frankly admit I felt considerable relief

when the train in which I was travelling was safely over these crossings.

They have thousands of miles of good concrete road. One trip I made was nearly 300 miles all of which was on first-class concrete road. The coach in which I travelled reached 65 m.p.h. in many places, but the country was so flat and uninteresting that I wished it would attain 165 m.p.h. This, I think, is the reason why they put high power engines in their cars. Enormous sums of money are being spent on what are called grade crossings. This, in plain English, means taking the roads under the railways, and although there are so many points to deal with that very many years must elapse before any real impression is made, each one will reduce the terrible accident risk.

Civil aviation has made enormous strides over there, and there must be scores of air routes giving regular service between the more important cities. This is largely due to the long distances between these places and the fact that the centre of the country is so flat makes this form of travel comparatively safe and popular.

America has a problem, particularly in the large cities, in the coloured population. They are rapidly increasing in numbers and, in many ways are a thorn in the flesh of the whites. They are steadily invading every walk of life and what will happen when they have a numerical preponderance is very difficult to forecast.

I had no opportunity to examine wage systems, or cost of living or matters of similar nature. It was found, however, that wages in both the motor car and machine tool trade were 30 to 35 dollars per week for skilled men, but whether this meant for a full week's work or for the short hours that seemed to be worked generally, I cannot say. No one seemed troubled by the forty-hour week, which is the standard working period, and those who had sufficient orders simple worked more hours. This suggests that forty hours per week merely means a wage rate in its effect. Some of the shops pay a simply flat rate, others have a bonus scheme on the lines of the Weir method, but I met no instance of the complicated systems that are being lauded in this country. The actual payment of wages in some cases is made throughout the works by cheques, on account of the frequent raids on messengers carrying notes and cash to the works. In this connection, I must express the extraordinary astonishment I felt when I saw bank messengers openly carrying loaded revolvers on a peaceful main thoroughfare.

With regard to the cost of living. No doubt, rents are very high in the big cities, clothes cost double what they do here, and cotton is the principal material used, woollen goods being not only scarce but almost prohibitive in price. Actual food, however, seemed to be much the same price as this country. Other articles were considerably cheaper, notably electric light bulbs, but the home produced article was somewhat eclipsed by Japanese imports which

were cheaper still, and they suffer from a flood of goods from that country.

Their methods of taxation are mystifying to a stranger. Federal tax, state tax, local tax, sales tax, and so on. They have only recently adopted an income tax system, and while the general attitude is, "If it is for the general good—well—I'll pay," individually they are not too happy about it. They ask how much has been wasted on recovery schemes and where is it going to end. I expect the end will be much the same as this country—they will have to manage on what is left.

There are many other points which would interest you but I shall have to leave them. At the commencement of this letter I told you a little of their friendliness and hospitality, but I want to say here that I found everyone I came in contact with extremely helpful, kindly, and willing to do anything in their power to assist the stranger in a strange land, so much so that at times it was difficult to remember I was a stranger until something in their habits or customs reminded me of the fact.

The school leaving age is much higher there than here and it struck me as curious to see young men and young women leaving the day schools during the afternoon. This appears one way of dealing with juvenile labour problems. The women of America are generally very well dressed and take great care of their personal appearance, and in this they are aided and abetted by the menfolk, who are extremely deferential in many ways to their women. It is customary for men using a hotel lift to remove their hats if a lady should be present, but they have no compunction about smoking the most axphyxiating cigar that could possibly be made.

There is great familiarity between the executive staff and the humbler employees. The managing director or president addresses his men and is addressed himself by christian names; he will inquire how a labourer's wife or family are progressing when sick; at the same time, he will have a staff of trained men ready for dealing with industrial disputes to the extent of providing fire-arms and maintaining a supply of tear gas. I think you will agree that this sort of thing would make a homely little strike, such as we are accustomed to, seem a very tame affair.

I found no organisation there which exactly corresponds with the Institution of Production Engineers, but there is an enormous amount of interest taken in technical matters and so far as engineering is concerned, America is wide awake and ready to take full advantage of every new discovery that science or practice has to offer.

It is not my intention to sum up all these points, or even to specify the good or bad as I see them but rather to leave them open for your reflections, but I shall be happy to amplify or explain anything

that may be ambiguous or in any way not clear.

I realise that I have by no means exhausted the subject, but have rambled on from one point to another without sequence or perhaps, even, orderly thinking, but I do hope that I have at least interested you. I shall conclude by saying that as the wooded slopes of this country came in view on my return, I felt that I had been privileged to enjoy a most interesting experience, one that I should recall pleasant memories of for a long time, but, that it was good to see old England again, and as I passed through the bar at Southampton I recalled that the wall around that old city stood there in the days when Columbus discovered America.

With every good wish,

I remain yours sincerely,

R. H. YOUNGASH.

and so on, and it is quite easy for them to get the printed papers, attend the meetings, take part in the discussion, whereas we in England keep our different Institutions in water-tight compartments. The Institution of Civil Engineers talk about bridges, railways, and waterworks; the Institution of Electrical Engineers talk about all things electrical, and many other Societies, all are in separate compartments, and if an engineer has any kind of interest at all he can only be a member of all of them! The Association of German Engineers (V.D.I.) is organised on very similar lines to the American one, one big organisation with all kinds of branches, members having rights in all the sections.

MR. YOUNGASH: Mr. Wright is probably correct in his remarks about national opinion, but I think the primary reason is because the country is so enormous. There is a large number of States, many of which are bigger than the whole of England, and probably people who are separated by so many thousands of miles cannot hold exactly the same opinion about national matters because of this difference of geographical position. There seemed to be perhaps an absence of opinion rather than differing opinions. It seemed as though their attitude was, "Well, I don't care what happens" —a negative attitude rather than a positive attitude—on various little matters which we discussed. On the other hand, there are at times widespread feelings. I was there during the time that the man paid the penalty for murdering the small Lindbergh child. There was a very widespread feeling there that that ought never to have been permitted, that as it had dragged out for such a long time, it would have been more humane—and the Americans pride themselves in that direction—to have found some other way out. In that connection, they were all very clear and definite that such a thing could not have happened in England.

With regard to engineering institutions, I believe Mr. Wright is quite right. I merely drew attention to the fact that so far as I could find there was no Institution which ran more or less parallel with the Institution of Production Engineers.

MR. C. S. WOOLLARD: I was very interested to hear Mr. Youngash's letter, because I have spent quite a lot of time in America. I have been across there between 50 and 60 times and can bear out Mr. Youngash, particularly with regard to some of his points which might be interesting to enlarge upon. The wooden houses have their advantages in that it does away with a lot of trouble in moving, because they simply jack up the house entire and take it down the street with a traction engine. It seems to do away with a lot of trouble, but rather takes up room in the street while it is going on.

With regard to the variations in temperature, I think Mr. Youngash has rather understated these. To give an idea of the extreme

cold, I have seen hoses filling the fresh water tanks on a ship which, as you know, have a very high pressure, going at full speed at six o'clock in the evening, and by six o'clock in the morning, they have been cutting them up in 10 ft. lengths and taking them below to freeze them out!

With regard to the heat, it was no uncommon sight to see dead horses, lying in the street, covered with a tarpaulin, awaiting collection.

I was interested in Mr. Youngash's opinion of the attitude of American people towards British people. There seemed to be some jealousy on the part of the Americans against the British, particularly before the war, and although the American nation is made up of practically every nationality under the sun, it was a generally expressed opinion that the only people who were looked upon and made to feel that they were foreigners, were the British. It occurs to me that the comradeship that has been brought about by the war has improved the feeling between America and this country.

MR. YOUNGASH: With regard to houses, it might be a virtue to be able to move them whole—I do not know. It may be a little quicker than taking them down brick by brick and putting them up again. Primarily, houses are not built and placed in a position with a view to moving them, otherwise we might, in this country, have them on wheels and perhaps dodge the rates and taxes. American houses are very convenient, very well planned and designed, and they have everything in the way of convenience that man can devise for women's comfort. There are certain disadvantages in these wooden houses. One is, of course, that they very quickly heat up and they very quickly loose heat, but they get over that by central heating systems which are universal, and although years ago they invariably used hot air, to-day they are going over entirely to water.

The disadvantages are things like these. An ordinary workman has to spend anything from twelve English pounds upward in buying fuel to keep his house warmed so that he is able to live in it through the winter.

In the houses of those who can afford something better, they have generally automatic oil burners, which are regulated by a thermostat which is set at definite heat and maintains that temperature through some range of outside temperatures. For normal use, during the winter it will keep the heat constant all the time.

I have mentioned in the letter that these extremes of temperature undoubtedly cause the blood of the individuals to be thin, so that they could stand the intense cold, without greater warmth than is usual here.

I was very deeply impressed by the fact that although I came into contact with a large number of people not in one instance did I see a person with an ordinary cold such as some Englishmen seem to have all the winter. Whether it is due to the temperature at which they keep their rooms, or whether it is due to the difference of atmosphere or something of that sort, I do not know. We are told that the air in the centre of the plateau, both in America and in Canada is so dry that when they get temperatures of 70° below zero they are still able to live. How much truth there is in that, I do not know, but I can tell you from my own personal experience that one morning I went out of the hotel for a matter of half-an-hour because I felt hot and stuffy. It had been snowing, and there was just a thin layer of snow, but I did not feel the cold at all. I walked around without a coat or hat, and was amazed to find the thermometer on the wall showed 10° of frost! I venture to suggest that 10° of frost in this country feels really cold.

Another disadvantage in this direction is that all the water pipes which bring the water to the houses have to be put in at least 6ft. below ground level because the normal frost penetration is 5 ft.

I think you will agree that that is rather a nuisance when they come to move these houses and have to dig a 6 ft. trench to put the water pipe in!

With regard to the attitude of Americans toward Englishmen, I have already told you these are my own opinions, and I went so far as to emphasise it and say that they might be considered to be peculiarly mine. They may not coincide with anyone else's. I I found everywhere the utmost friendliness. I believe you would find that condition absolutely universal if you go there as a visitor from England to the United States, but our friend says, if you go to work there you won't find it the same. This may of course be so.

MR. A. ADAMSON: I have visited many plants in the United States, and consequently have come into contact with many Americans, and I can bear out all that Mr. Youngash has said to-night. There are some plants not so modern, and there are some of them very up-to-date.

As regards the hospitality of the Americans, they seem to have the knack of saying, "He is from the old country," and they make you very welcome indeed. In fact, they do not care how much they do for you. I was just recalling two instances that happened in two different cities in America. I was visiting one plant and had spent some hours there, and I said, "I cannot remain any longer because I am going to another plant," and I mentioned the name of the firm. That firm was a competitor in the same city, and one would have thought they would keep me as far as they could from them, but no. They said, "We want to show you something else;

it will be too late to go there to-day, go to-morrow morning ; Mr. So-and-So will take you there."

I met him next morning and he drove me to the other end of the city. Then he was not content, but went right into the office, spoke to them about my visit the day previous to his works, and remained there for about half-an-hour, talking, then went away. I came across a similar thing in another city, where two competitors seemed not to be afraid to go into each others' offices, not afraid to take a stranger into their confidence. As regards being glad to come back to England, I remember standing on the deck when two gentlemen (I do not know who they were) were standing near, and one of them said, " Now, if we sight England in daylight, it will be so pleasant to see the green fields " I always remember that. We had not seen much green during our stay.

MR. YOUNGASH : With regard to the feeling between competitors, I came across one instance whilst I was there, a firm who make a special line of machinery, and have one other competitor in the States. There is a difference in their machine, and although this firm had an inquiry from someone for plant for making certain parts which would have paid him to sell, he wrote back saying that so-and-so's machine was better for the work he wanted to do !

With regard to plant there, I suppose it is the same there as it is here. You go to almost any works, and they have some particular machines or operation of which they are more than ordinarily proud, every person who visits them has to see this, so, unless you are very careful, you do not get any real idea of what their places are like. On the other hand you may see something impressive.

One big firm of machine tool builders had a number of instances of silicosis which was contracted while cleaning castings, and as an effort towards reducing the risk they devised a process of which they are to-day very proud and which itself has the merit of reducing their costs almost unbelievably. They make large castings which, you do not require me to tell you, are full of sand and lumps of iron and various things which foundry people put inside them. These machine tools in embryo are dropped through a hole in the floor into a concrete pit. Outside this pit they have a very powerful electrically driven hydraulic pump which pumps water up to a pressure of 450 lb. per sq. in. A jet of this high pressure water is directed against the core sand in the castings, and in less time than it takes me to tell you they have bored holes through, and the sand is falling out at an unbelievable rate. It is true they have not entirely eliminated the risk of silicosis, but they have reduced the difficulties and troubles of breaking up the core. In addition to the time that they have saved in cleaning the cores out of those castings, which is enormous, they have made working conditions better than they were, and have saved quite an amount of money.

On the other hand, I came across no instance of a works which has a pension scheme of any kind. One firm has appropriated a certain amount of money which they pay to old servants, and they told me that the amount of money does not vary much because as fresh men come on, so the old men fade out, but they did it purely as an act of grace on their part, there was no scheme about it.

I do know that security of tenure such as prevails in most decent firms in this country is almost entirely missing over there. If you go there, Mr. So-and-so, in charge of a certain department conducts you round and shows you what there was to see, but if you go there in twelve months and asked for Mr. So-and-so, you might discover him sweeping up the shop, completely relegated.

MR. H. HANDFORTH: Mr. Youngash mentions that wool is not used in bulk in such a cold country. To me that is a contradiction, and I would like enlightening on that point. Then he mentions a a special process of de-scaling hardened parts and the deposition of tin on the naked steel. I do not know whether he can extend it technically, but I am very interested. The next point is hydraulics in machine tools. Is that expanding in America quicker than it is here, or is it progressing about the same rate? The next and final point is, did he see anything of the hydraulic or hydro-electric schemes which we are led to believe are so prevalent in the U.S.A.? Have they the overhead wires that we have here?

MR. YOUNGASH: What I said was that the principal material used for clothing was cotton, as wool was so scarce and dear. You can obtain wool if you pay for it. The reason cotton is the principal material is because cotton is grown there so extensively, and wool is not so easy to get. If people would pay the price they could get woollen goods, but they do not need them to the same extent because they keep their places so hot. A man, when in the street, wears an extremely heavy overcoat, but when indoors usually has nothing on but a singlet (they do not wear waistcoats) and his overcoat when he goes outside.

In the works, the executive staff at any rate always wear their coats, but there again they have very thick overcoats, get into cars which are heated, and keep out of the cold air in their homes or clubs.

There is very little home life there as we understand it, and they spend a lot of their time in their country clubs or in the hotels. There is also nationally a tremendous amount of drinking—probably a reaction after the prohibition period. But I am digressing somewhat from Mr. Handforth's question.

With regard to the descaling, I expect you are familiar with the electro-pickling process which consists of a current passing through a solution, usually sulphuric acid, and attacking the metal underneath the scale, it is the ordinary pickling process except

that it is accelerated by the passage of an electric current which causes atoms of hydrogen to penetrate the scale. The point about this new process is that there is included an electro-deposition of tin. It does not adhere to the scale, but the moment the bare metal is exposed it instantly covers it and protects it from any further action, so that when one part is descaled, it is covered by tin and the process is complete when the whole of the scale has fallen off and the piece is entirely covered with a very thin coat of tin.

With regard to hydraulics in machine tools, I do not think the position is substantially different from what it is here. I do not think I can safely answer either way as to whether the use of hydraulics is gaining ground or not.

With regard to hydraulic power stations, the best known example of that, of course, is the Niagara Falls which, as everybody knows, is a really marvellous scheme, there is also the Boulder Dam station now beginning to operate. Colossal schemes are undertaken there with impunity, schemes which would, in this country, raise a tremendous amount of question before we ever attempted them. I believe they would start on this Severn Barrage scheme cheerfully if they thought there would be anything in it.

With regard to distribution, I do not know how their high tension wires are carried round. I did, however, see some metal structures similar to those we have, but I do know that in many of the towns, they have their electric supply carried on poles in the streets in the same way that you would find it in a few isolated districts in this country, though these would I expect be low tension currents.

Curiously enough, in America, which has apparently plenty of timber, they use the most objectionable looking poles, leaning to one side, with their cross bars lying at all sorts of angles, and not even straight poles.

MR. E. T. COOK : I join the other speakers in expressing my appreciation of Mr. Youngash's letter. I would like him, if possible, to tell us a little about the conditions under which the operatives work in America. For example, what is the shop discipline like ; are they allowed to smoke during working hours, and any other point which would lead us to understand what shop life is like there ?

MR. YOUNGASH : Shop conditions, so far as I can tell you, vary the same as they do here. If you go to the redoubtable Henry Ford's works I should think you could not get in if they could detect that you had been smoking. He has a particularly rooted objection to smoking and drinking. There is a rail round the works, about a hundred yards away, and you must not smoke when you enter that rail. As for drinking, I do not imagine anyone who drank would be employed by the Ford Co. I am afraid, however, that Ford's men do drink and smoke without him knowing.

In some of the factories where they have a line of operations, work in general is extremely well balanced, but in others it is very badly balanced, and you see one man who is very hard pressed to keep up with his job, while the next man has an easy operation that leaves him with quite a lot of time to spare, but so far as I can tell you, those conditions are confined to the motor trade. In the machine tool trade, you find conditions exactly the same as you would find them here. At one important aero engine works, I noticed two fellows slipping outside the back door for a cigarette.

MR. EDWARDS: Arising out of the question of shop conditions, there is one question I should like to ask. I think Mr. Youngash mentioned the standard working week of forty hours which he seemed to consider quite settled. Is it the practice in the U.S.A. to spread these over the six working days of the week, or has it become more prevalent to use part of Saturday as a holiday? Another point is Mr. Youngash's remarks on roads, and the question of accidents. He referred to level crossings, and similar road troubles, and at the same time mentioned that there were very fine concrete roads of great length. First of all, I would assume that these concrete roads connect large towns, and I am wondering what the conditions are of the roads in the smaller towns? Arising out of the same point, what does he consider the accident risk there in relation to this country? Does he think that the average accident risk, which we usually refer to as the "toll of the road," higher there than here?

Another point he has given me, as, probably many others in the room, rather a different view upon is the black population in America. I think the Englishman's attitude is rather tolerant, and we consider the Americans intolerant towards the black population, but Mr. Youngash has given us rather a different picture, in that it is possible for the white races to be outnumbered by the black population.

One other question I would like to refer to is the incidence of taxation. Mr. Youngash made some remarks about that, but he did not tell us how it compared with taxation in this country. Japanese imports were mentioned. I always thought that the U.S.A. was the one country in the world which could deal with the question of imports effectively and could keep out anybody they wanted, and I am wondering, therefore, why the Japanese are able to export so much of their stuff to the States?

MR. YOUNGASH: I can only conclude you think I am a sort of Encyclopaedia! With regard to the forty-hour week, forty hours is the legal, standard working week for factories. If I were to express my own personal opinion, it is a complete farce! America has had the five-day week for many years in places like the motor-car factories, because they have had to adopt Saturday morning for adjust-

ments, repairs, and renewals, but it will be remembered that when motor-car factories are busy they work continuously from Monday morning until Saturday morning, they have to close down Saturday morning for maintenance work. So far as I know there is no difference in the rates of pay on any shifts. The moment they have the slightest sign of a blockage, and a blockage arises quickly when they cannot dispose of their cars, the whole works are shut down. It may occur two or three times in a week, so that I should be very surprised to know that many people in the motor trade are working more than forty hours, but it is not because of the forty-hour week ; if the working week was sixty hours, they would still only be able to work forty so far as I can see. When you get outside, conditions are simply this : that if there is work and it is wanted the men work longer hours. Whether there is any increase in the rate of pay attached to those overtime hours, I do not know—he certainly puts the hours in.

With regard to roads, outside the town the roads are either concrete or mud tracks. The question of accident risk, is very difficult to answer unless one has more facts than I have, because accident risk must bear some relation to the number of cars or miles run, and I have no information of that kind. There is no doubt that America has very many accidents. It was reported some years ago, I think about 1930, that there were more people killed in motor-car accidents between the end of 1919 and 1930 than there were American casualties in the war. Since 1930 there will have been a considerable increase because the number of cars on the road is continually getting greater. In the town of New York, particularly, I should imagine that the accident risk is lower than it is in London, because the rectangular layouts lend themselves to traffic control.

They have, you will remember, avenues running in one direction, and streets running across. Every avenue is a two-way road, every street is one-way.

In order to control the traffic they have an extremely simple system, which is remarkably effective. They have signals exactly the same as we have (I suppose we got them from there) but these signals are set some distance apart on on the corners of the avenues and streets, and they are spaced so that each traffic signal covers perhaps three or four streets, perhaps two. You have a line of traffic passing straight up the avenue, and when you come to a signal, you may be two blocks away, wherever you are you stop ; you cannot cross the first street you come to, exactly the same as if you were at the signal light, although this may be some distance away : you must stop.

The effect of that is very marked. In England, everybody would roll up to that signal light. In America they stay where they are, and when they start off again the traffic is spaced as it was before the

stoppage ; you do not get any bunching of the traffic. This not only relieves traffic congestion, but must also reduce accident risk.

With regard to the coloured population, in a general way, educated blacks are able to compete with whites in any direction, and the problem is how to keep the upper hand. Their numbers are increasing very rapidly and the time is not far distant when there will be equal numbers of blacks and whites. The risk of it lies in the fact that none of us know what the attitude of the black will be if he attains a position of numerical superiority. He will probably do what the white has done for many years—he will dictate the terms.

With regard to Japanese imports, perhaps there are some ulterior motives, but whatever it is, there are more Japanese goods, of sorts, than there are here, and that is saying something !

It is difficult to express an opinion about taxation, there are, as here, direct and indirect taxes, and I can only hazard a guess, which is that taxes are not more than half what they would be under similar circumstances in this country.

MR. A. MCNAB : Regarding the attitude of Americans to Englishmen, on the staff of one firm that we visited there was a typist who apparently left England fifteen years ago, and she was brought into our presence to see the " real " Englishmen. That happened on many occasions. People were brought up to view " real " Englishmen from England.

I was particularly impressed by the cleanliness of the shops in the States, particularly those appertaining to my particular business. The English shops are not comparable ; I think the reason is that we have so many different types of work to do in one shop, whereas in America they process one particular component in one particular section, and so are able to avoid having oddments lying about which tend to make the shop look untidy.

In respect to the things provided for the employees, I did see several good examples of shop rooms fitted with lockers, showers, etc., and a very convenient canteen where men could retire if there was a shut down. I thing English business houses have got a lot to do to catch up with America in that respect.

Another point that interested me was that the American boss, instead of dictating, rather uses the men under his control to greater advantage, in my opinion, than the English manager does. The American makes friends with his men, and consequently gets more from them.

For instance, if they are tooling a job, or deciding the process of producing a job, anybody can have a say in it, and anything that is feasible is experimented with. The American's policy is to find out the best possible way of doing a job, and instead of having to rush things through, they are able to give much thought and experi-

ment to the new processes and new jobs. The pause before the production is one reason why manufacturing costs are probably so low in the States.

I think Mr. Youngash has very pleasantly related his impressions of America, and I congratulate him on his very nice letter. I shall have to get him to write me one some day.

MR. YOUNGASH: I am going to say this, that it was a pleasure and a privilege to have the company of two young men who were everything that one could wish for as companions on such a trip, and Mr. McNab was one of them.

With regard to English people out there, there is no doubt the Englishman there is truly pleased to see someone from the "old country," and this young lady Mr. McNab mentioned left England some years ago, she had very hazy ideas of it, and her one ambition is to save enough money to come over to England and have another look at English bluebells.

With regard to cleanliness of shops, there are shops here that are clean. First of all it depends on the nature of the work; secondly it depends on the standard which, gentlemen, you and I set. I saw some shops there which were no better than the worst places one could find in this country, and others which were models of cleanliness. We were authoritatively informed that Ford has one man out of every 12 doing nothing but cleaning, so you will understand he is spending *some* money on cleaning.

With regard to the way that the Americans address one another, I do not think you should take that too seriously. It is much the same as it is here; one word from the boss makes them do just as they like.

On the other hand, it is good policy to listen to what everyone has to say and sort out the best for yourself.

One example of their attitude is in Henry Ford himself. He refused to listen to the advice of everybody connected with his works about the old Model T until he was nearly ruined. He refused to believe that anybody could want anything better than his old car, and even to-day, if you talk to one of these gentlemen who have the pleasant duty of selling machine tools, he will tell you that there is one place where they cannot do anything except just supply what they are told, whether they have something better or not, and that is Henry Ford's works.

MR. R. C. FENTON: I am sure we have all appreciated, not only the letter, but the way in which Mr. Youngash has couched the letter, and brought out those little highlights of interest in the most admirable way. We shall go home and think quite a lot about it. I have myself spent several years abroad, and know that feeling when you come home and see the green grass and narrow

lanes, and it certainly makes one appreciate this country, as Mr. Youngash pointed out. The Bar at Southampton is an object of wonderment to many Americans coming to this country. I have heard them say, "Fancy having that across your street," but if you asked them, "Would you pull it down?" they would say, "No. We would not. We should move it into a park where we could look at it properly." I am sure everyone will join with me in thanking Mr. Youngash very much for his letter, and according him a very sincere vote of thanks.